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DEPOSITION OF METALS in the vicinity of MATTABI MINES LIMITED, IGNACE, 1986

Ontario
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DEPOSITION OF METALS
in the vicinity of
MATTABI MINES LIMITED, IGNACE
1986

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NORTHWESTERN REGION
ONTARIO MINISTRY OF THE ENVIRONMENT

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INTRODUCTION

A survey conducted in February, 1979, revealed elevated levels of copper, iron, lead and zinc in snow around the Mattabi Mines Limited base metal concentrator near Ignace.[1] Similar results were found in a moss exposure study and in vegetation and soil surveys conducted in June and July, 1979.[2] To determine current contaminant levels and to develop an appropriate abatement program, snow, soil, vegetation and moss bag exposure surveys were conducted during 1986.

METHODS

Samples of snow, trembling aspen foliage, soil (0-5 cm and 5-10 cm) and exposed moss bags were collected from 14 sites near the Mattabi concentrator (Figure 1) and from two control sites remote from the study area. Snow was collected on January 23, 1986, soil on July 14, and trembling aspen foliage on August 18. Moss samples were exposed from July 14 to August 18. All samples were collected following standard Ministry sampling procedures.[3]

Snow, vegetation, moss and soil samples were analyzed for copper, iron, lead and zinc. In addition to the foregoing analyses, soil was analysed for loss on ignition and snow for conductivity. Soil and snow pH were also determined. All analyses were performed at the Ministry's laboratory in Thunder Bay.

Vegetation in the vicinity of the study sites was examined for visible evidence of stress caused by disease, insects, contaminants or physiological factors.

Contaminant guidelines, developed by the Ministry for snow, soil, vegetation, and experimentally exposed moss, were applied in the interpretation of the data. Exceedence of the guidelines would suggest that contamination may be present, but would not necessarily imply adverse effects.

RESULTS AND DISCUSSION

SNOW

Snow cover depth averaged 39 cm (centimetres) and ranged from 5 to 59 cm at the sampling locations. Trace to heavy deposits of gray particulate matter, in thin bands, were noted in the snow profile or on the snow surface near the ore concentrator at sampling sites 3, 4, 5, 7 and 8.

Analysis results from snow meltwater samples for 1979 and 1986 are presented in Table 1. In both years, metal concentrations were highest near the ore concentrator and declined as distance from the plant increased. In 1986, metals were distributed in a pattern similar to that shown in Figure 2 for zinc. Conductivity and pH were slightly above background levels in the survey area, but showed no consistent trend with distance from the mine site. Copper, iron, lead and zinc levels at most sampling sites were usually much lower in 1986 than in 1979. Despite this decline, metal concentrations in 1986 were still well above Ministry guidelines in the area near the ore concentrator.

We estimate that the fallout of copper, iron, lead and zinc was 130, 170, 620 and 1900 kg (kilograms), respectively, in the snow within the area bounded by the guideline levels for each contaminant. This estimate is based on an average snow depth of 39 cm and applies to the period (69 days) between the date when the first permanent seasonal snowfall occurred and the date of the survey.

A correlation matrix for selected parameters in the 1986 survey is presented in Table 2. There were strong, positive, linear relationships between copper, iron, lead and zinc. These relationships suggest that the four metals originated from a common source. The strong negative relationship between the metals and distance from the concentrator implicates the concentrator as the emission source.

TREE FOLIAGE

No serious insect or disease problems were encountered during the study period in forest vegetation at any of the sampling locations. Some foliar injury caused by white birch leaf miner, trembling aspen leaf blotch miner and mites on mountain maple was noted. No symptoms of metal toxicity were present on any foliage in the area of investigation.

Chemical analysis results for the 1979 and 1986 surveys are presented in Table 3. Levels of copper, iron, lead and zinc significantly exceeded Ministry guidelines at locations nearest the concentrator. The distribution pattern for copper, iron and lead was similar to that for zinc, shown in Figure 3. Levels of all metals in tree foliage were higher in 1986 than in 1979 at most sampling locations.

SOIL

Tables 4 and 5 present results for the 1979 and 1986 soil surveys. Copper, lead and zinc were well above Ministry contaminant guidelines in surface soils in the vicinity of the concentrator building. Metals levels decreased rapidly with increasing distance from the mining complex and from nearby roads and rail lines. The distribution pattern for zinc in surface soil, plotted in Figure 4, was similar to those for copper and lead. High metal concentrations also occurred in sub-surface soil at several sampling sites (Table 5). Metal levels, except for iron, were lower in sub-surface than in surface soil, as expected when contamination is from airborne deposition. Metal concentrations in 1986 were similar to those found in 1979, except for lead in surface soil which was higher in 1986 than in 1979.

MOSS

Moss analysis results, in Table 6, showed that significant concentrations of airborne copper, lead and zinc occurred near the mining complex between mid-July and mid-August, 1986.

Distribution patterns for all metals for which moss samples were analysed in moss were similar to that shown in Figure 5 for zinc. Metal levels were highest near the concentrator and decreased rapidly with increasing distance from this source. Iron was slightly elevated at some sites. Metal levels (except lead) were generally lower in 1986 than in 1979.

DISCUSSION AND CONCLUSIONS

The 1986 surveys at Mattabi Mines Limited showed that concentrations of copper, lead and zinc significantly exceeded Ministry guidelines in snow, tree foliage, soil and experimentally exposed moss. Iron also exceeded Ministry guidelines in snow, tree foliage and moss. The highest metal levels were found near the ore concentrator. Metal levels in snow were generally lower in 1986 than in 1979. This decrease is likely due, at least in part, to the difference in sampling dates, which would result in the accumulation of higher metal levels in snow in the 1979 survey. Production levels at the mine were also higher in 1979 than in 1986 during the months immediately preceding sampling dates. The higher metal concentrations in tree foliage in 1986, compared to 1979, may be ascribed to the later sampling date in 1986. Overall, the data from vegetation, soil and snow show that there may have been a decline in metal emissions in 1986 compared with 1979. Factors other than emission levels, however, may also have affected this apparent improvement.

Our studies show that fallout of copper, lead and zinc has been significant in the area around Mattabi's ore concentrator. This fallout has increased metal concentrations in local soils and vegetation, has contributed to metal levels in surface and groundwater drainage from the area, and has been directly deposited on nearby water bodies. However, the main sources of contamination of local water bodies are leachate from acidified waste rock and surface run-off from the railcar loading area. The Ministry is developing a program to require abatement of discharges from these sources.

REFERENCES

1. Racette, D. J. and H. D. Griffin. 1979. Snow sampling survey in the vicinity of Mattabi Mines Limited, Ignace, February, 1979. Ontario Ministry of the Environment.

2. Racette, D. J. and H. D. Griffin. 1981. Phytotoxicology investigations in the vicinity of Mattabi Mines Limited, Ignace, June-July, 1979. Ontario Ministry of the Environment.

3. Ontario Ministry of the Environment. 1983. Field investigation procedures manual, Phytotoxicology Section, Air Resources Branch.

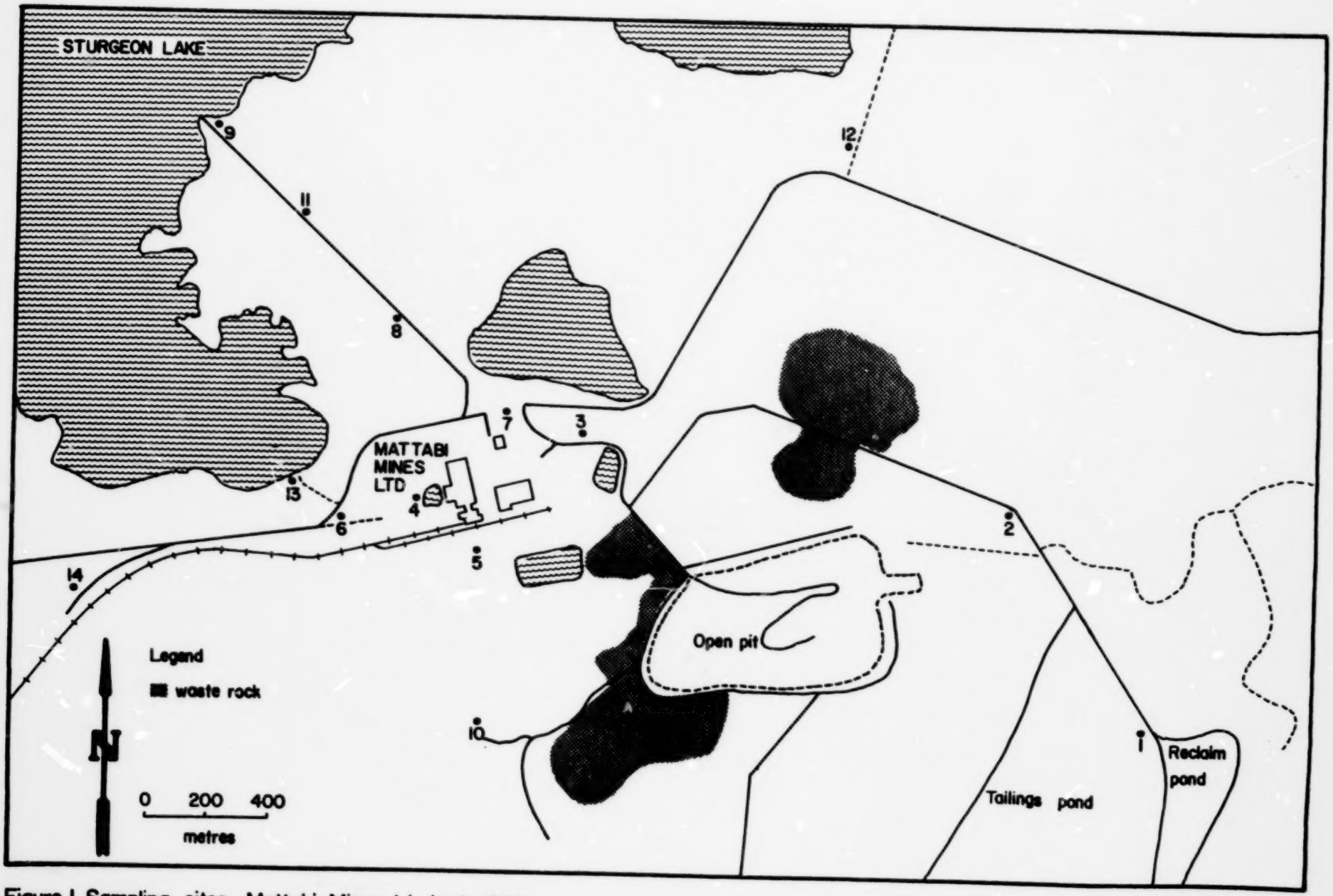

Figure I. Sampling sites, Mattabi Mines Limited, 1986.

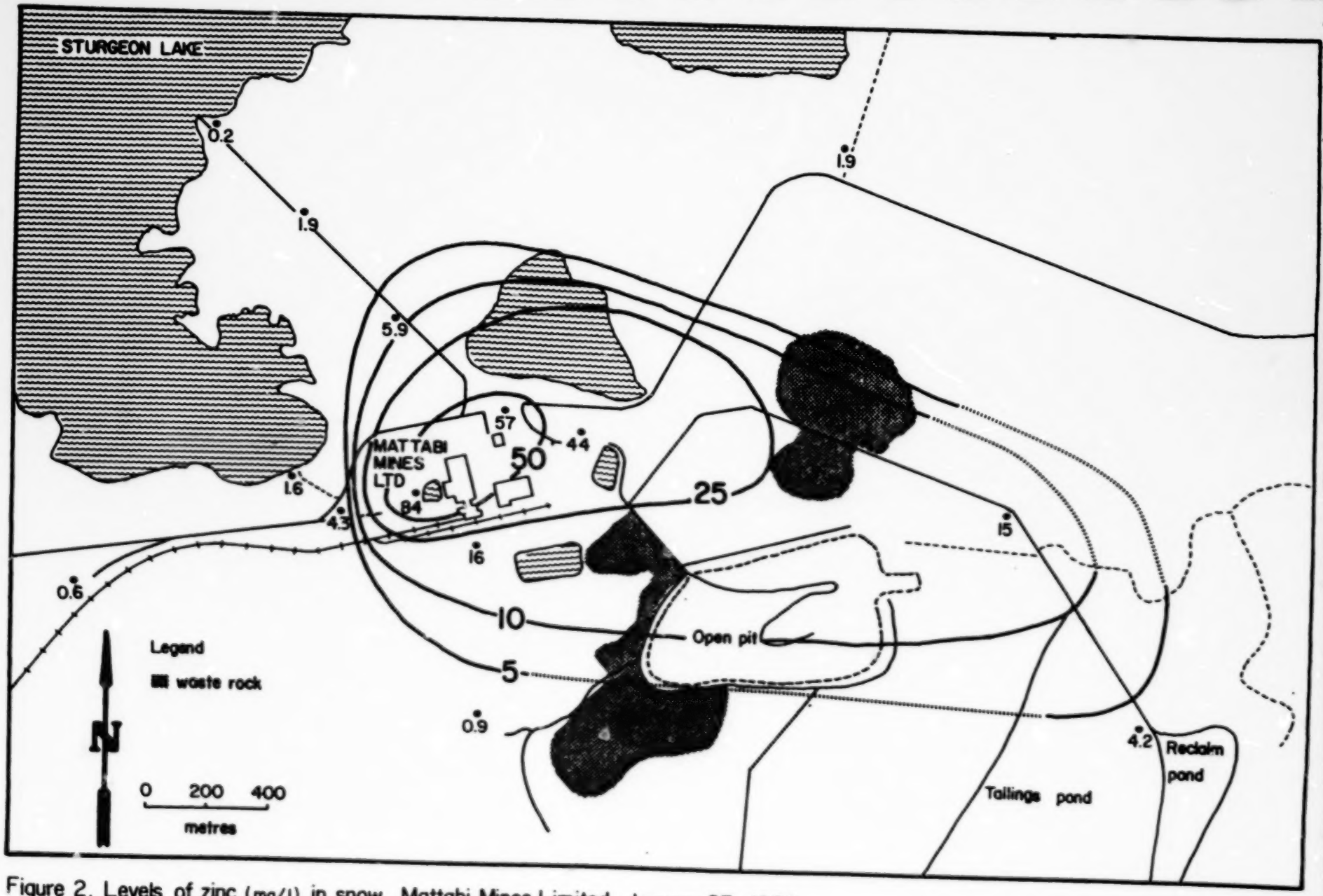

Figure 2. Levels of zinc (mg/l) in snow, Mattabi Mines Limited, January 23, 1986.

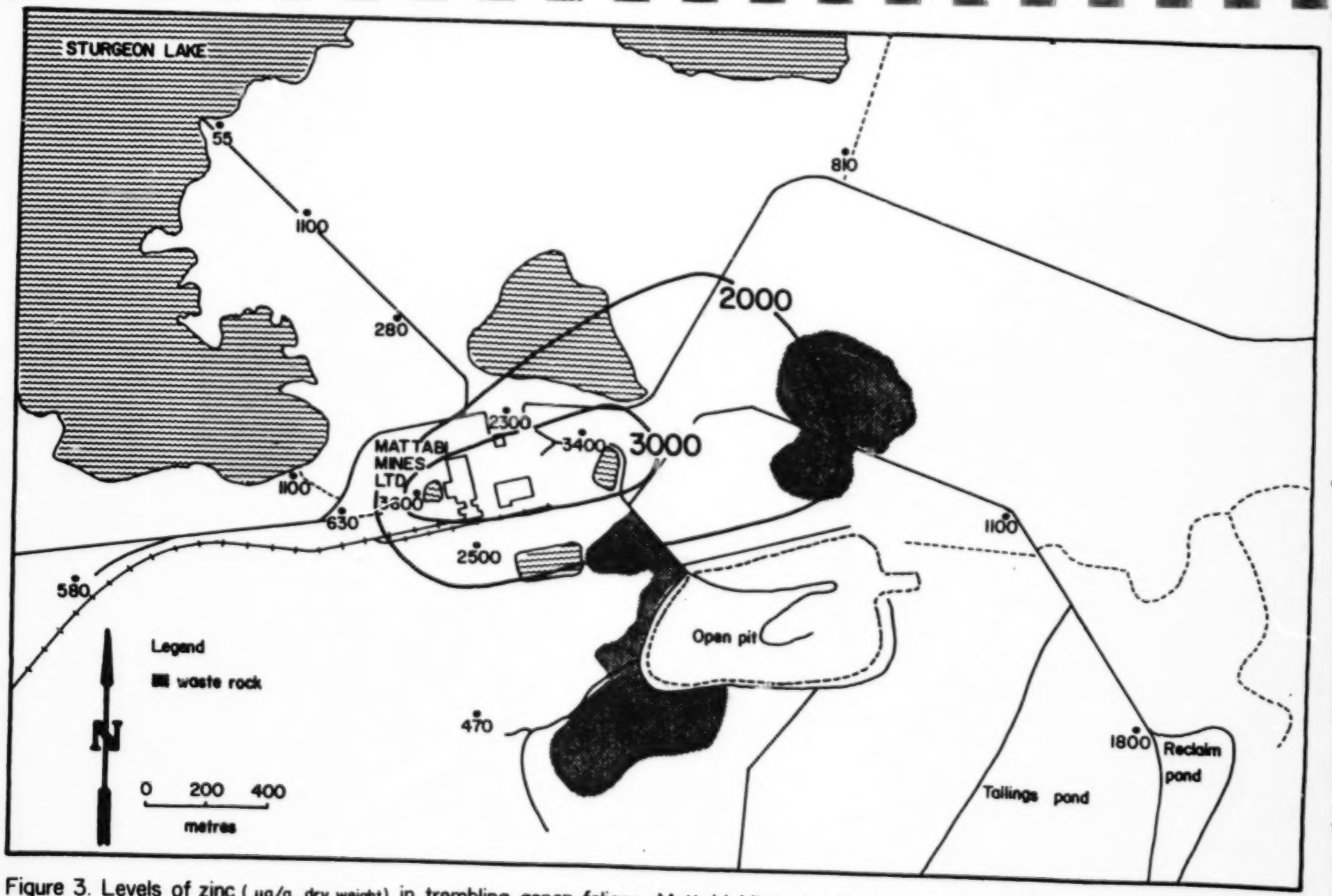

Figure 3. Levels of zinc (µg/g, dry weight) in trembling aspen foliage, Mattabi Mines Limited, August 18, 1986.

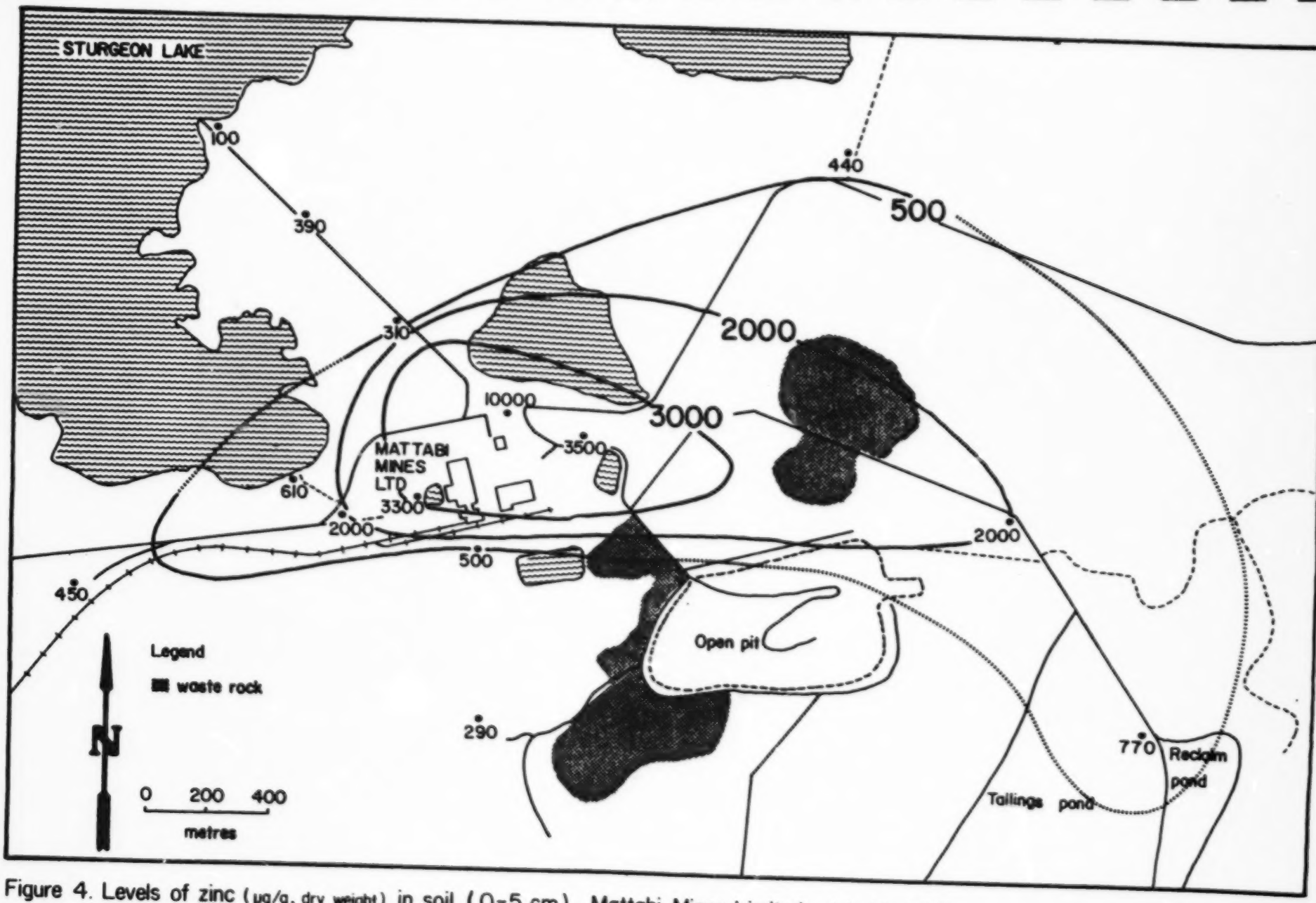

Figure 4. Levels of zinc (µg/g, dry weight) in soil (0-5 cm), Mattabi Mines Limited, July 14, 1986.

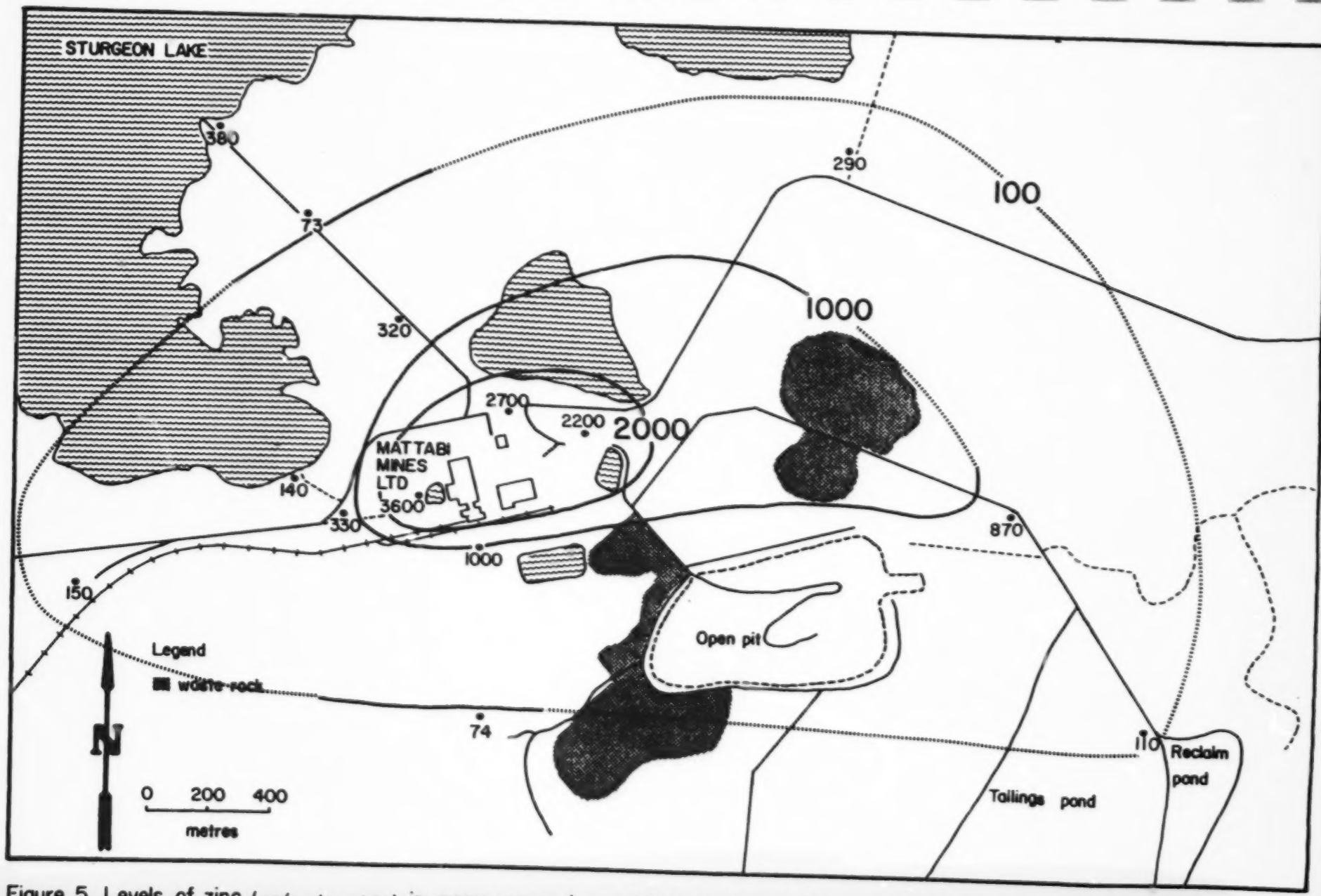

Figure 5. Levels of zinc (µg/g, dry weight) in moss exposed near Mattabi Mines Limited, July 14 to August 18, 1986.

TABLE 1. Levels of copper, iron, lead, zinc (mg/ℓ), conductivity (μmhos/cm), and pH in meltwater from snow in the vicinity of Mattabi Mines Limited, February, 1979, and January, 1986.

Station	Copper		Iron		Lead		Zinc		Conductivity	pH
	1979	1986	1979	1986	1979	1986	1979	1986	1986	1986
1	0.4	0.1	2.0	2.3	0.2	0.2	0.9	4.2	41	9.8
2	2.0	0.8	8.0	12.0	0.9	1.1	6.0	15.0	10	5.8
3	34.0	4.5	164.0	56.0	11.0	5.9	101.0	44.0	18	6.5
4	190.0	9.3	438.0	59.0	28.0	8.3	136.0	84.0	24	6.9
5	58.0	2.2	258.0	11.0	11.0	2.9	885.0	16.0	13	6.1
6	46.0	0.6	92.0	4.5	8.0	0.9	58.0	4.3	11	5.6
7	31.0	7.4	246.0	68.0	15.0	8.0	126.0	57.0	26	6.5
8	3.0	0.2	8.0	2.2	0.8	0.2	4.0	5.9	7	5.0
9	2.0	<0.1	4.0	0.4	0.7	<0.1	3.7	0.2	11	5.0
10		<0.1		0.8		<0.1		0.9	7	5.0
11		<0.1		0.8		<0.1		1.9	15	6.1
12		0.2		2.3		0.2		1.9	7	5.5
13		0.2		1.4		0.3		1.6	11	5.9
14		<0.1		0.7		<0.1		0.6	10	4.9
Controls	<0.1	<0.1	0.4	0.2	<0.1	<0.1	0.2	0.1	8	4.8
Contaminant guideline	0.06		0.7		0.07		0.3		60	

TABLE 2. Correlation matrix of selected parameters in meltwater from snow collected near Mattabi Mines Limited, January 23, 1986.

	Cu	Fe	Pb	Zn	Conductivity	pH
Fe	.95*					
Pb	.98*	.98*				
Zn	.99*	.95*	.97*			
Conductivity	.44	.43	.43	.44		
pH	.26	.26	.26	.28	.94*	
Distance[a]	-.56*	-.50*	-.57*	-.50*	.26	.36

*Denotes a significant correlation for pairs of elements at a probability level of 95%.

[a]Distance measured from centre of the concentrator building.

TABLE 3. Levels of copper, iron, lead and zinc (µg/g, dry weight) in trembling aspen foliage, Mattabi Mines Limited, July 16, 1979 and August 18, 1986.

Site	Copper		Iron		Lead		Zinc	
	1979	1986	1979	1986	1979	1986	1979	1986
1	12	10	130	470	4	16	460	1800
2	28	48	210	660	11	78	460	1100
3	300	290	1200	1300	190	440	1900	3400
4	110	490	680	6100	150	870	1600	3600
5	55	120	170	470	29	220	1700	2500
6	26	100	310	510	14	300	860	630
7	150	220	1200	2400	130	380	1500	2300
8	20	27	110	1100	10	64	310	280
9		5		820		11		55
10		7		86		<3		470
11		8		46		3		1100
12		24		460		20		810
13	35	26	140	130	15	60	1200	1100
14	35	7	150	52	11	6	360	580
Control	14	6	120	56	<1	<3	160	150
Guideline[a]	20		500		30		250	

[a]Upper limit of normal. Zinc guideline may be inappropriate for trembling aspen, which is an accumulator of zinc.

TABLE 4. Levels of copper, iron, lead, zinc (µg/g, dry weight), organic matter (percent) and pH in surface soil (0-5 cm), Mattabi Mines Limited, June 11, 1979 and July 14, 1986.

Site	Copper		Iron		Lead		Zinc		Organic Matter	pH	
	1979	1986	1979	1986	1979	1986	1979	1986	1986	1979	1986
1	63	470	17000	9700	100	12	75	770	12	3.4	5.4
2	990	2300	14000	21000	110	720	1900	2000	57	4.6	3.5
3	2100	1900	23000	34000	560	750	13000	3500	5	6.7	5.3
4		1300		18000		1700		3300	1		7.9
5	3600	2600	19000	14000	370	1600	1900	500	11	3.3	3.0
6	1100	1700	20000	15000	450	870	2400	2000	5	7.8	5.6
7	2100	5400	31000	50000	420	2600	3200	10000	2	3.7	7.7
8	3400	450	23000	12000	600	120	1000	310	6	5.1	4.9
9		84		13000		<3		100	3		6.1
10		190		11000		6		290	6		6.1
11		300		10000		79		390	16		4.6
12		200		12000		5		440	11		4.5
13	700	660	5800	6500	120	160	680	610	9	4.6	3.9
14	230	64	15000	6300	70	11	720	450	1	6.1	7.1
Control	12	52	7300	7400	9	5	34	20	4	4.7	4.8
Guideline[a]	60		35000		150		500				

[a]Upper limit of normal.

TABLE 5. Levels of copper, iron, lead, zinc (µg/g, dry weight), organic matter (percent) and pH in sub-surface soil (5-10 cm), Mattabi Mines Limited, June 11, 1979 and July 14, 1986.

Site	Copper		Iron		Lead		Zinc		Organic Matter	pH	
	1979	1986	1979	1986	1979	1986	1979	1986	1986	1979	1986
1	30	40	9500	9500	11	<3	37	40	2	3.9	4.9
2		94		9200		<3		230	4		4.0
3	290	340	12000	32000	110	13	7100	940	4	6.3	6.4
4		320		21000		11		790	1		8.0
5	110	300	14000	12000	12	9	230	79	2	3.5	3.7
6		67		20000		4		280	2		5.9
7		520		32000		10		3300	2		7.2
8		130		8600		<3		110	2		5.0
9		34		26000		<3		30	3		5.4
10		40		23000		<3		46	3		6.0
11		48		22000		<3		40	5		4.1
12		68		18000		<3		66	9		4.3
13		35		7300		<3		67	2		4.6
14		140		10000		<3		540	2		7.6
Control	6	36	11000	20000	4	<3	21	22	4	4.7	5.2
Guideline[a]	60		35000		150		500				

[a]Upper limit of normal for soil 0-5 cm.

TABLE 6. Levels of copper, iron, lead and zinc (µg/g, dry weight) in moss exposed from June 11 to July 16, 1979 and from July 14 to August 18, 1986.

Site[a]	Copper		Iron		Lead		Zinc	
	1979	1986	1979	1986	1979	1986	1979	1986
1	36	12	2500	1000	30	20	240	110
2	13	81	1600	3000	58	140	670	870
3	1900	120	8400	1600	930	200	7300	2200
4	410	410	5400	2600	570	800	27000	3600
5	240	100	2100	1600	97	140	4000	1000
6	110	75	2600	1200	79	230	1400	330
7	1100	2400	7600	5000	580	480	7200	2700
8	35	15	1500	210	22	30	410	320
9		6		54		6		380
10		6		640		18		74
11		8		780		18		73
12		42		2400		34		290
13	110	17	1800	1000	58	43	850	140
14	67	30	1400	660	40	33	540	150
Exposed Controls	7	3	1000	750	11	15	110	43
Unexposed Controls	4	3	1000	700	7	11	52	36
Guideline[b]	8		1700		35		100	

[a]Site numbers as shown in Figure 1.

[b]Upper limit of normal.

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